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SUMMARY REPORT ON QUALITY OF INTERSTATE WATERS

(YELLOWSTONE RIVER) (MONTANA-NORTH DAKOTA)

PUBLIC HEALTH SERVICE, WASHINGTON, D.C.

DECEMBER 1960

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SUMMARY REPORT ON QUALITY OF INTERSTATE WATERS (YELLOWSTONE RIVER) (MONTANA-NORTH DAKOTA)

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16. Abstracts

Water quality of the Yellowstone River sub-basin from Laurel, Montana to its mouth in Wyoming was examined. Tabular data are presented on: sources of pollution, stream flow, interference with water uses, adequacy of treatment measures, action of official agencies, Public Helath Service grants for construction of waste treatment facilities, nature of delays in abating pollution and time schedule for proposed remedial action. Appended are a summary of phenol analyses for Laurel, Billings, and Huntley, Montana, treatment needs, and water quality objectives.

17. Key Words and Document Analysis. 17a. Descriptors

17b. Identifiers/Open-Ended Terms

*Water quality
*Water pollution sampling
Tables(Data)
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Montana
Wyoming
North Dakota
Stream flow
Water supply
State agencies
Construction
Water pollution control equipment

17c. COSATI Field/Group 13B

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SUMMARY REPORT ON QUALITY OF INTERSTATE WATERS

(YELLOWSTONE RIVER)

(MONTANA - NORTH DAKOTA)

This report, one of a series developed by the Public Health Service, is a factual presentation of conditions which exist in a specific location or area, based on data and information furnished by State, Interstate and Federal agencies concerned. This report is a brief summary of such material in the files of the Public Health Service as of the time the report is issued. The report will be revised from time to time to reflect new information and changing conditions.

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

December 1960

SUMMARY REPORT ON QUALITY OF INTERSTATE WATERS

YELLOWSTONE RIVER

(MONTANA - NORTH DAKOTA)

(Data Current to December 1960*)

I. LOCATION

The Yellowstone River Basin, length - 440 miles, maximum width - 320 miles, comprises an area of 70,400 square miles. The river originates in northwestern Wyoming (Yellowstone Lake) and flows north into Montana at river mile 628 and north by northeast through Montana and into North Dakota at river mile 15. It then flows into the Missouri River at river mile 1,664. The river flows a total distance of 671 miles.

The report concerns the Lower Yellowstone River sub-basin from Laurel, Montana (river mile 367) to its mouth. The interstate tributaries, the Powder, Bighorn, and Tongue Rivers, are not included and are the subjects of separate reports. The Powder and Tongue Rivers do not contribute to interstate pollution at present.

The principal communities in this sub-basin are Billings (the largest community in the entire basin), Forsyth, Miles City, Glendive, and Sidney, Montana.

II. SOURCES OF POLLUTION

Although municipal wastes are discharged into the stream along its course in Montana, industrial wastes create the major source of interstate pollution causing taste and odor problems in domestic water supplies. The principal source of this problem is considered to be phenols or phenolic-like compounds originating from oil refinery wastes

*Based on data and information available.

and/or from other industrial wastes, algae, and natural materials in the stream. However, the role of municipal wastes in contributing to the problem must not be overlooked.

TABLE NO. 1 - BASIC DATA ON SOURCES OF POLLUTION 1/

Municipality or Industry	River Miles Above Mouth	Sewered Population	P. E. Waste Before Treatment	Nature of Wastes	Treatment Provided	P. E. Discharge to Watercourse
Yellowstone River						
Laurel, Mont.	367	4,000	4,000	Municipal	Primary	2,800
Farmers Union Cen. Exchange Refinery 2/	365	123	6,780	Oil Refinery	Oil Separators	6,780
No. Pac. RR 2/	364	-	84	Machine Shop	Oil Separators	84
Billings, Mont.	346	30,000	30,000	Municipal	Primary	16,300
Great Western Sugar Co.	345	400	523,000	Sugar Beets	Steffens waste concentrator, lime slurry pond, pulp drier, pulp press water reused	98,000 3/
Continental Oil Co. Refinery	343	132	Undet.	Refinery	Separator and regulated discharge	4,400
Midland Empire Meat Packing Co.	343	70	6,900	Meat Packing	None	6,900
Pierce Packing Co.	343	200	15,700	Meat Packing	Grease traps	15,700
Carter Oil Co. Refinery 2/	340	250	Undet.	Oil Refinery	Oil separator & evaporation	35,900

TABLE NO. 1 - BASIC DATA ON SOURCES OF POLLUTION 1/

Municipality or Industry (cont'd)	River Miles Above Mouth	Sewered Population	P. E. Waste Before Treatment	Nature of Wastes	Treatment Provided	P. E. Discharge to Watercourse
Big Horn River	279	Subject of Summary Report				
Yellowstone River						
Hysham, Mont.	260	275	275	Municipal	Septic Tank	250
Forsyth , Mont.	231	2,000	2,000	Municipal	Primary	1,600
Fort Keogh, Mont.						
U.S. Agr. Exp. Sta.	182	190	190	Domestic	Primary	50
Miles City, Mont.	181	7,200	7,236	Municipal	None	7,236
Chicago, Milwaukee & St. Paul RR Maint. Shops	180	-	Undet.	Machine shop	None	Undet.
Terry, Mont.	135	500	500	Municipal	Septic Tank	450
Glendive, Mont.	92	5,060	5,132	Municipal	None	5,132
No. Pac. RR Maint. Shop	92	-	Undet.	Machine shop	None	Undet.
Sidney, Mont.	30	3,000	3,036	Municipal	None	3,036
Holly Sugar Co.	30	183	200,000	Beet Sugar	None	200,000

1/ Unless otherwise noted, data from U. S. Department of Health, Education, and Welfare, Public Health Service, Inventory of Municipal & Industrial Waste Facilities in Montana, Washington, D.C., December 31, 1957; Inventory of Municipal & Industrial Waste Facilities in North Dakota, Washington, D.C., December 31, 1957

2/ U. S. Department of Health, Education, and Welfare, Public Health Service, Pollution of Yellowstone River as Related to Taste and Odor Problems in Municipal Waste Supplies, Montana and North Dakota, July 1956, p. 7

3/ Operates October to December

TABLE NO. 1 - BASIC DATA ON SOURCES OF POLLUTION 1/

Municipality or Industry (cont'd)	River Miles Above Mouth	Sewered Population	P. E. Waste Before Treatment	Nature of Wastes	Treatment Provided	P. E. Discharge to Watercourse
Fairview, Mont.	20	1,200	1,200	Municipal	Primary	1,000
Mont.-N.D. State Line	15					

To date, discharges to the Yellowstone River from the sources of pollution in Montana have continued as indicated above.

Table No. 2 shows pertinent stream flow data taken from U. S. Geological Survey Reports for the Yellowstone River and Missouri River below the mouth of the Yellowstone River. Low flows occur in the winter when taste and odor problems have been experienced by municipal water systems.

TABLE NO. 2 - STREAM FLOW DATA IN cfs

No. and Location of gaging station	Years of Record	Average	Maximum	Minimum
Yellowstone River at Billings, Mont.	27	6,663	64,800	430
Yellowstone River at Miles City, Mont.	29	10,830	96,300	996
Yellowstone River at Sidney, Mont.	46	13,040	159,000	860
Missouri River near Williston, N.D.	30	20,450	231,000	1,320

Substantial pollution is contributed to the Yellowstone River at river mile 279 by the Big Horn River.

III. INTERFERENCE WITH WATER USES

Wastes discharged into the Yellowstone River from sources in Montana interfere with water uses in North Dakota by causing:

1. Deterioration of water quality so as to create taste and odor problems in public water supplies.

Taste and odor problems have occurred in the Williston, North Dakota, domestic water supply. Williston, which is located about twenty river miles below the confluence of the Yellowstone and Missouri Rivers, takes 0.9 million gallons daily from the Missouri River for its water supply. 4/

The Lower Yellowstone River has developed intermittent conditions, usually in fall or winter, resulting in severe taste and odor problems in municipal water supplies. Difficulties have occurred at Forsyth, Miles City, and Glendive, Montana, on the Yellowstone River. The taste and odor problems encountered by Williston, North Dakota, are attributed to the quality of the Yellowstone River also. 5/

The Huntley Project, 15 miles down stream from Billings, Montana, used water from irrigation ditches,

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4/ U. S. Public Health Service, Municipal Water Facilities - Inventory and Mobilization Readiness Planning Data for Larger Communities - United States, 1954 revised. Washington, D.C., Division of Sanitary Engineering Services, November 1955

5/ U. S. Department of Health, Education, and Welfare, Public Health Service, Pollution of the Yellowstone River as Related to Taste and Odor Problems in Municipal Water Supplies in Montana & North Dakota, July 1956, See Appendix A

after treatment, for public water supply. Because of pollution, they now must buy water from a well in Ballentine, Montana. The water costs $0.25 per tank/wagon (750 gallons) at the source and $2.50 delivered. 6/

2. Deterioration of water quality so as to affect fish and aquatic life.

In 1950, for a 55 mile stretch below Laurel and Billings, Montana, fish were unsuitable for eating because of an oily taste.

There have been fish kills reported on the Yellowstone between Laurel and the mouth. In November 1955, dead fish were found below the oil refinery and underpass drain outfalls at Laurel, Montana.

IV. ADEQUACY OF TREATMENT MEASURES 7/

The cities of Glendive and Sidney, Montana, with the aid of Public Health Service grants, are constructing waste stabilization ponds which will provide adequate treatment. Miles City, Montana, provides no treatment facilities. Treatment facilities at Billings, Forsyth , Hysham, and Terry, Montana, are inadequate.

Treatment facilities at the Holly Sugar Company Plant in Sidney, Montana; the Midland and Pierce Packing Company Plants, and the Great Western Sugar Company at Billings, Montana, are inadequate. The adequacy of other industrial waste treatment facilities is not known.

6/ Federal Security Agency, Public Health Service, Yellowstone River Drainage Basin - A Cooperative State-Federal Report on Water Pollution, January 1952

7/ See Appendix B

V. ACTION OF OFFICIAL AGENCIES

a. Federal and Federal-State joint action

A number of cooperative studies have been conducted by the Public Health Service and the State Health Departments in the Yellowstone River Basin, and published by the Public Health Service. The most recent one, entitled "Pollution of the Yellowstone River as Related to Taste and Odor Problems in Municipal Water Supplies in Montana and North Dakota," was published in July 1956. Others are: "A Comprehensive Program for Control of Water Pollution, Missouri Drainage Basin," published in July 1953; "Yellowstone Drainage Basin", published in January 1952; and "Missouri River Drainage Basin", published in 1951.

TABLE NO. 3 - PUBLIC HEALTH SERVICE GRANTS FOR CONSTRUCTION OF WASTE TREATMENT FACILITIES

Municipality	Date Approved	Amount	Estimated Total Cost of Project	Type of Project	Status of Project
Billings, Mont.	Mar. 57	$101,447	$338,157	Intercepting sewer	Completed
Glendive, Mont. (Rural Imprvmt. Dvlpt)	Mar. 58	25,931	86,436	New waste stab. ponds	Completed
Glendive, Mont. (City)	Feb. 59	170,615	568,717	New waste stab. ponds	Under construction
Sidney, Mont.	Mar. 59	52,500	175,000	New waste stab. ponds	Under construction

b. State Action

In 1955, the State Legislature passed the Water Pollution Act of the State of Montana. The act created the State Water Pollution Council with authority over all water pollution policies in the State, except those involving public health. As a result of the cooperative State - Federal study of 1955, the results of which were published in 1956, recommendations were made for waste treatment needs of the municipalities and industries on the Yellowstone River in Montana. These recommendations, with slight modifications, were adopted by the Montana State Board of Health. In 1957, the Council adopted "Water Quality Objectives and Minimum Treatment Requirements for Montana Surface and Underground Waters", for use in the classification of Montana's surface waters.

On September 2, 1958, the Montana Water Pollution Council classified the Yellowstone River and its tributaries. The reach from Laurel to the North Dakota State Line was given a "B" classification. This classification specified water quality for waters being used for domestic water supply and food processing water after complete water treatment. The classification requires that domestic sewage must be given a minimum of primary treatment with effective disinfection. 8/

8/ See Appendix C.

In 1958, the Montana State Board of Health, in cooperation with six Montana communities and the Public Health Service, established a continuous carbon filter sampling program for the period September to January. The purpose was collecting and identifying the materials which cause the taste and odor problems in local water supplies and then establishing a satisfactory abatement program. State personnel routinely collected stream samples for phenol analysis during the winter of 1958.

A cooperative State-Federal-Local surface water quality station has been established at Sidney, Montana to make monthly carbon filter sample collections.

VI. NATURE OF DELAYS IN ABATING POLLUTION

None.

VII. TIME SCHEDULE OR PROPOSED REMEDIAL ACTION

In 1952, the Montana State Board of Health advised municipalities in Montana, including Forsyth, Glendive, Miles City and Sidney of the need for sewage treatment and set July 1957 as the date that plans should be completed, with two additional years to finance and construct the necessary facilities.

Prepared and Approved by Region VI (Kansas City) December 19, 1960

Approved By Region VIII (Denver) December 1960

Approved by Enforcement Branch January 3, 1961

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2. U. S. Department of Health, Education, and Welfare, Public Health Service, Pollution of the Yellowstone River as Related to Taste and Odor Problems in Municipal Water Supplies in Montana and North Dakota, July, 1956. (The study is marked "CONFIDENTIAL")

3. Summary Report on Montana Stream Pollution Control Council Meeting, September 11, 1956.

4. U. S. Geological Survey, Quality of Surface Waters of the United States, Washington D.C., U. S. Government Printing Office, 1960.

5. Montana State Board of Health, Yellowstone River Tastes and Odors, Helena, Montana, Montana State Board of Health, January 10, 1958.

6. Federal Security Agency, Public Health Service, Missouri River Drainage Basin, Washington, D.C., 1951.

7. Federal Security Agency, Public Health Service, Yellowstone River Drainage Basin, Washington, D.C., January 1952.

8. U. S. Department of Health, Education, and Welfare, Public Health Service, A Comprehensive Program for Control of Water Pollution - Missouri Drainage Basin, Washington, D.C., July 1953.

9. U. S. Department of Health, Education, and Welfare, Public Health Service, Inventory of Municipal and Industrial Waste Facilities in North Dakota, Washington, D.C., 1957.

APPENDIX A

Laurel, Billings, Forsyth, Miles City, and Glendive, Montana, obtain public water supplies from the Yellowstone River. Forsyth, Miles City, and Glendive have experienced sporadic intense taste and odor problems. These municipalities provide complete water treatment, including coagulation, sedimentation, filtration and post chlorination, but this procedure has not completely eliminated the tastes and odors. Miles City and Glendive also soften water. The formation of chlorophenol during water treatment could possibly intensify the problem. Phenol has been found in the water supply at Forsyth. a/ It appears that this taste and odor is caused by industrial wastes, principally oil refineries or industrial waste combinations, and/or products of plankton or other aquatic organisms. Organic wastes from municipalities may contribute to this problem.

A summary of the phenol content of the Yellowstone River above and below Billings, Montana is given in Table A attached to this Appendix. These data show the variability of this constituent and may indicate its tie-in with taste and odor problems occurring in winter and spring. In the winter of 1954 when such problem occurred, analyses were made at six stations by the Montana State Board of Health. The results of thirty-six tests in six days of sampling showed the phenol content at the Billings intake to be essentially 0 parts per billion, that at the Forsyth intake as high as 100 parts per billion, Miles City as high as 84 parts per billion, and Glendive as high as 60 parts per billion.

a/ Summary Report on Montana Stream Pollution Control Council Meeting, September 11, 1956.

In the cooperative study of November 7 to 13, 1955, a season when no taste and odor was reported, the phenol analyses, increased from 0 parts per billion at Laurel, Montana, to a high of 33 parts per billion at Huntley, and decreased to a high of 2 parts per billion at Miles City, and a high of 4 parts per billion near Carterright, North Dakota. In the Montana State Board of Health, monthly test program, forty-two tests at Huntley from February 3, 1955, to December 7, 1957, ranged from 0 to 35 parts per billion of phenol with an average of 8.9 parts per billion. These figures show the high values which occur typically in winter and early spring.

The Montana State Board of Health stream quality standard of 5 parts per billion phenolic compounds in drinking water supplies has been exceeded frequently in the past.

Recent waste abatement action by Montana industries may have reduced greatly the likelihood of detrimental phenol concentrations in the Yellowstone River.

TABLE A - SUMMARY OF PHENOL ANALYSES - YELLOWSTONE RIVER, MONTANA b/

Sampling Station	Period or Date	Number of Samples	Results (Phenols - ppf
Laurel, Montana	Oct. 1959	1	4.9
	Nov. 1959	1	0
	Dec. 1959	1	0.6
	Jan. 1960	1	0
	Feb. 1960	1	2.8
	Mar. 1960	1	13.1
	April 1960	1	0
	May 1960	1	0
	June 1960	1	2.5
	July 1960	1	0
	Sept. 1960	1	0
Billings, Montana	Oct. 1959	1	7.1
	Nov. 1959	1	2.0
	Dec. 1959	1	1.7
	Jan. 1960	1	1.6
	Feb. 1960	1	0.9
	Mar. 1960	1	10.1
	April 1960	1	0
	May 1960	1	1.2
	June 1960	1	2.3
	July 1960	1	0
	Sept. 1960	1	0

TABLE A - SUMMARY OF PHENOL ANALYSES - YELLOWSTONE RIVER, MONTANA b/

Sampling Station (cont'd)	Period or Date	Number of Samples	Results (Phenols -
Huntley, Montana	Oct. 1959	1	8.2
	Nov. 1959	1	8.0
	Dec. 1959	1	17.2
	Jan. 1960	1	32.6
	Feb. 1960	1	10.7
	Mar. 1960	1	38.1
	April 1960	1	11.4
	May 1960	1	2.0
	June 1960	1	2.5
	July 1960	1	0
	Sept. 1960	1	0

b/ U. S. Geological Survey (Billings, Montana Office by letter).

Appendix B

TABLE 8 - TREATMENT NEEDS - MUNICIPALITIES AND INDUSTRIES IN MONTANA

Municipality or Industry	Treatment Provided	Treatment Needs
Billings, Montana		
Midland Empire Packing Co.	None	Removal of all blood and settleable and floating solids.
Pierce Packing Co.	None	Removal of all blood and settleable and floating solids.
Forsyth, Montana	Primary	Enlarge existing plant.
Miles City, Montana	None	New plant; primary or equivalent.
Chicago, Milwaukee & St. Paul RR Shops	Not Known	Not Known
Glendive, Montana	None	New plant; primary or equivalent.
Sidney, Montana	None	New plant; primary or equivalent.
Holly Sugar Co.	None	Remove all settleable and floating solids and reduce BOD load from about 18#/t beats to 8#/ton.

Appendix C

WATER QUALITY OBJECTIVES AND MINIMUM TREATMENT REQUIREMENTS FOR MONTANA SURFACE AND UNDERGROUND WATERS

GROUP A - WATER SUPPLY, DRINKING, CULINARY & FOOD PROCESSING (Without treatment other than simple disinfection and removal of naturally present impurities)

Organisms of the Coliform Group	- Most probable number coliform bacterial content of a representative number of samples should average less than 50 per 100 ml. in any month.
Floating, Suspended Settleable Solids and Sludge Deposits	- None attributable to sewage, industrial wastes, or other wastes or which, after reasonable dilution and mixture with receiving waters, interfere with the best use of these waters for the purpose indicated.
Taste or Odor Producing Substances	- None attributable to sewage, industrial wastes or other wastes.
Dissolved Oxygen	- Greater than five parts per million except for underground waters.
pH	- Hydrogen ion concentration expressed as pH should be maintained between 6.5 and 8.5.
Toxic, Colored or Other Deleterious Substances	- None alone or in combination with other substances or wastes in sufficient amounts of such nature as to make receiving waters unsafe or unsuitable for use indicated. (U.S. P.H.S. Stdrs.)
Phenolic Compounds	- Less than 5 parts per billion.
Oil	- None.
High Temperature Wastes	- Not in sufficient quantities alone or in combination with other wastes to interfere with use indicated.
Minimum Treatment Requirements for Domestic Sewage	- Primary treatment and effective disinfection except in special cases as determined by the State Board of Health. Sewage lagoon treatment will meet this requirement.

GROUP B - WATER SUPPLY, DRINKING, CULINARY & FOOD PROCESSING (With treatment equal to coagulation, sedimentation, filtration, disinfection, and any additional treatment necessary for removing naturally present impurities)

Organisms of the Coliform Group	- MPN coliform bacterial content of a representative number of samples should average less than 2000 per 100 ml. and should not exceed this number in more than 20 percent of samples examined in any month when associated with domestic sewage.
Floating, Suspended Settleable Solids and Sludge Deposits	- None attributable to sewage, industrial wastes, or other wastes or which, after reasonable dilution and mixture with receiving waters, interfere with the best use of these waters for the purpose indicated.
Taste or Odor Producing Substances	- None attributable to sewage, industrial wastes, or other wastes which, after reasonable dilution and mixture will increase the threshold odor number above eight.
Dissolved Oxygen	- Greater than five parts per million except for underground waters.
pH	- Hydrogen ion concentration expressed as pH should be maintained between 6.5 and 8.3.
Toxic, Colored or Other Deleterious Substances	- None alone or in combination with other substances or wastes in sufficient amounts or of such nature as to make receiving waters unsafe or unsuitable for use indicated. (U.S.P.H.S. Stdrs.)
Phenolic Compounds	- Less than 5 parts per billion.
Oil	- None detectable.
High Temperature Wastes	- Not in sufficient quantities alone or in combination with other wastes to interfere with use indicated.
Minimum Treatment Requirements for Domestic Sewage	- Primary treatment and effective disinfection, except in special cases as determined by the State Board of Health. Sewage lagoon treatment will meet this requirement.

GROUP C - BATHING, SWIMMING AND RECREATION (Note: When waters are used for recreational purposes, such as fishing and boating, exclusive of bathing and swimming, the number 1900 may be substituted for 240 in statement of coliform objective)

Organisms of the Coliform Group	- MPN coliform bacterial content of a representative number of samples should average less than 240 per 100 ml. and should not exceed this number in more than 20 percent of samples examined when associated with domestic sewage.
Floating, Suspended Settleable Solids and Sludge Deposits	- None attributable to sewage, industrial wastes, or other wastes or which, after reasonable dilution and mixture with receiving waters interfere with the best use of these waters for the purpose indicated.
Taste or Odor Producing Substances	- None attributable to sewage, industrial wastes, or other wastes, which after reasonable dilution and mixture will interfere with the best use of those waters for the purpose indicated.
Dissolved Oxygen	- Greater than 5 parts per million.
pH	- Hydrogen ion concentration expressed as pH should be maintained between 6.5 and 8.5.
Toxic, Colored or Other Deleterious Substances	- None alone or in combination with other substances or wastes in sufficient amounts or of such nature as to make receiving waters unsafe or unsuitable for use indicated. (U.S.P.H.S. Stdrs.)
Phenolic Compounds	- Less than 25 parts per billion or none in sufficient amounts such as to impart a residual taste to recreational or commercial fish or other aquatic forms.
Oil	- None detectable.
High Temperature Wastes	- Not in sufficient quantities alone or in combination with other wastes to interfere with use indicated.
Minimum Treatment Requirements for Domestic Sewage	- Primary treatment and effective disinfection except in special cases as determined by the State Board of of Health. Sewage lagoon treatment will meet this requirement.

GROWTH AND PROPAGATION OF FISH AND OTHER AQUATIC LIFE (Includes waterfowl, furbearers, and other aquatic and semi-aquatic life)

Floating, Suspended Settleable Solids and Sludge Deposits	- None attributable to sewage, industrial wastes, or other wastes or which, after reasonable dilution and mixture with receiving waters interfere with the best use of these waters for the purpose indicated.
Taste or Odor Producing Substances	- None attributable to sewage, industrial wastes, or other wastes which will interfere with the palatability of recreational or commercial fish, or other edible aquatic forms.
Dissolved Oxygen	- Greater than 5 parts per million.
pH	- Hydrogen ion concentration expressed as pH should be maintained between 6.5 and 8.5.
Toxic, Colored or Other Deleterious Substances	- None alone or in combination with other substances or wastes in sufficient amount or of such character as to make receiving waters unsafe or unsuitable for use indicated.
Phenolic Compounds	- Less than 25 parts per billion or none in sufficient amounts such as to impart a residual taste to recreational or commercial fish or other aquatic forms.
Oil	- None detectable.
High Temperature Wastes	- Not in sufficient quantity as to increase the temperature of the receiving waters beyond that optimum for the normal aquatic life of the specific water.
Minimum Treatment Requirements for Domestic Sewage	- Primary treatment and effective disinfection. Sewage lagoon treatment will meet this requirement

CLASS B - AGRICULTURAL AND INDUSTRIAL WATER SUPPLY (Without treatment except for the removal of natural impurities to meet special quality requirements other than those classified under "A" above.)*

Floating, Suspended Settleable Solids and Sludge Deposits	- None attributable to sewage, industrial wastes, or other wastes or which, after reasonable dilution and mixture with receiving waters interfere with the best use of these waters for the purpose indicated.
Taste or Odor Producing Substances	- None attributable to sewage, industrial wastes, or other wastes which will adversely affect the marketability of agricultural or industrial produce.
Dissolved Oxygen	- Greater than 3 parts per million.
p^H	- Hydrogen ion concentration expressed as p^H should be maintained between 6.8 and 9.5.
Toxic, Colored or Other Deleterious Substances	- None alone or in combination with other substances or wastes in sufficient amounts or of such nature as to make receiving waters unsafe or unsuitable for use indicated. (U.S.P.H.S. Stdrs.)
Phenolic Compounds	- None in sufficient quantity as to make receiving waters unsuitable for use indicated.
Oil	- None detectable.
High Temperature Wastes	- Not insufficient quantities alone or in combination with other wastes to interfere with use indicated.
Minimum Treatment Requirements for Domestic Sewage	- Primary treatment and effective disinfection. Sewage lagoon treatment will meet this requirement.

*NOTE: Permissible limits for total concentrations percent sodium, boron, chlorides and sulfates to receive further study. Aggregated value for percent sodium is less than 69. Percent sodium means the ratio of sodium to total cations expressed in equivalent weights. Calculated from the formula: $\frac{Na}{Na + K + Ca + Mg} \times 100$ when Na, Ca, K, and Mg are all expressed in equivalents.

Water Quality Objectives of a Watercourse will apply at the point of discharge.

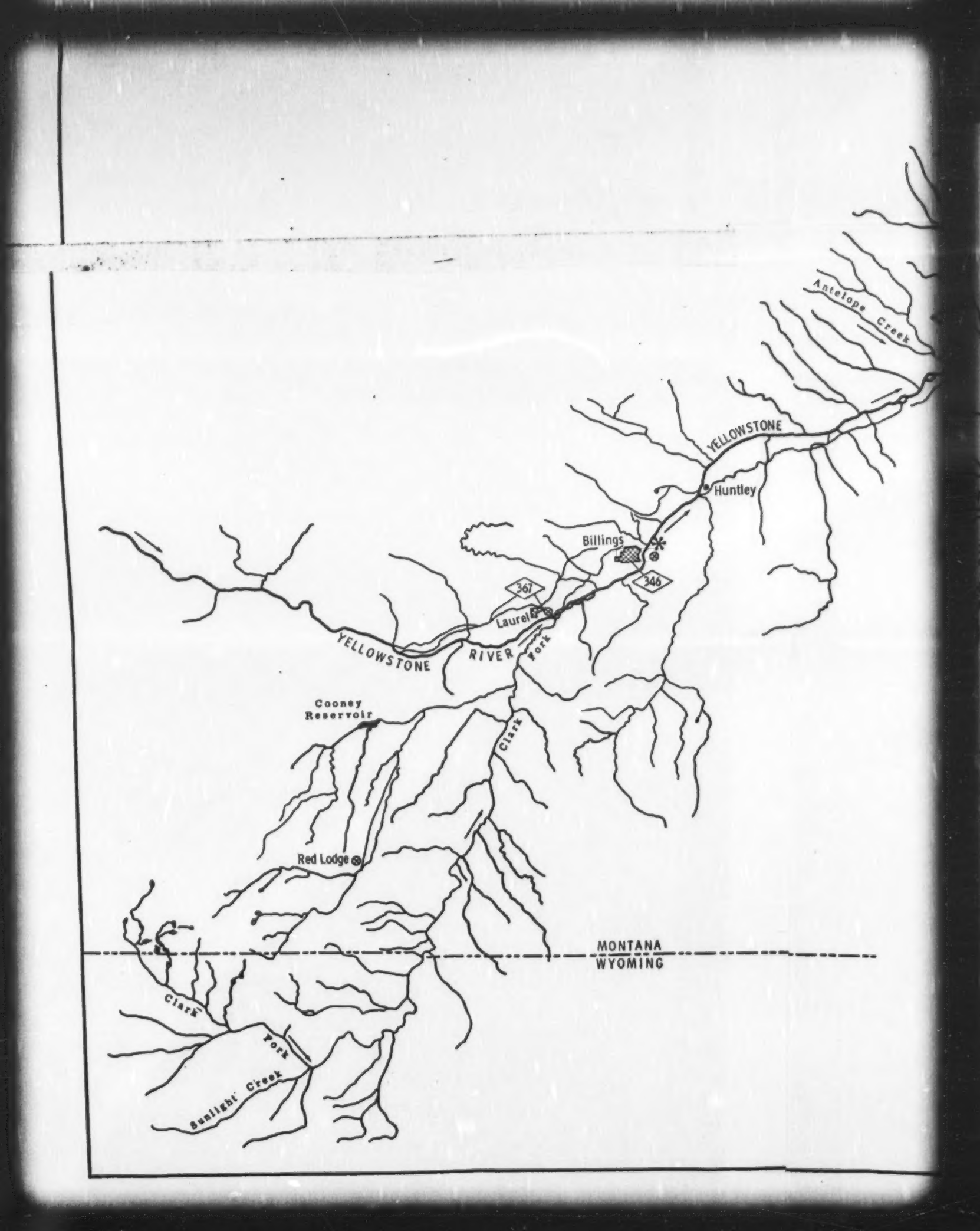
YELLOWSTO

MONTANA - N

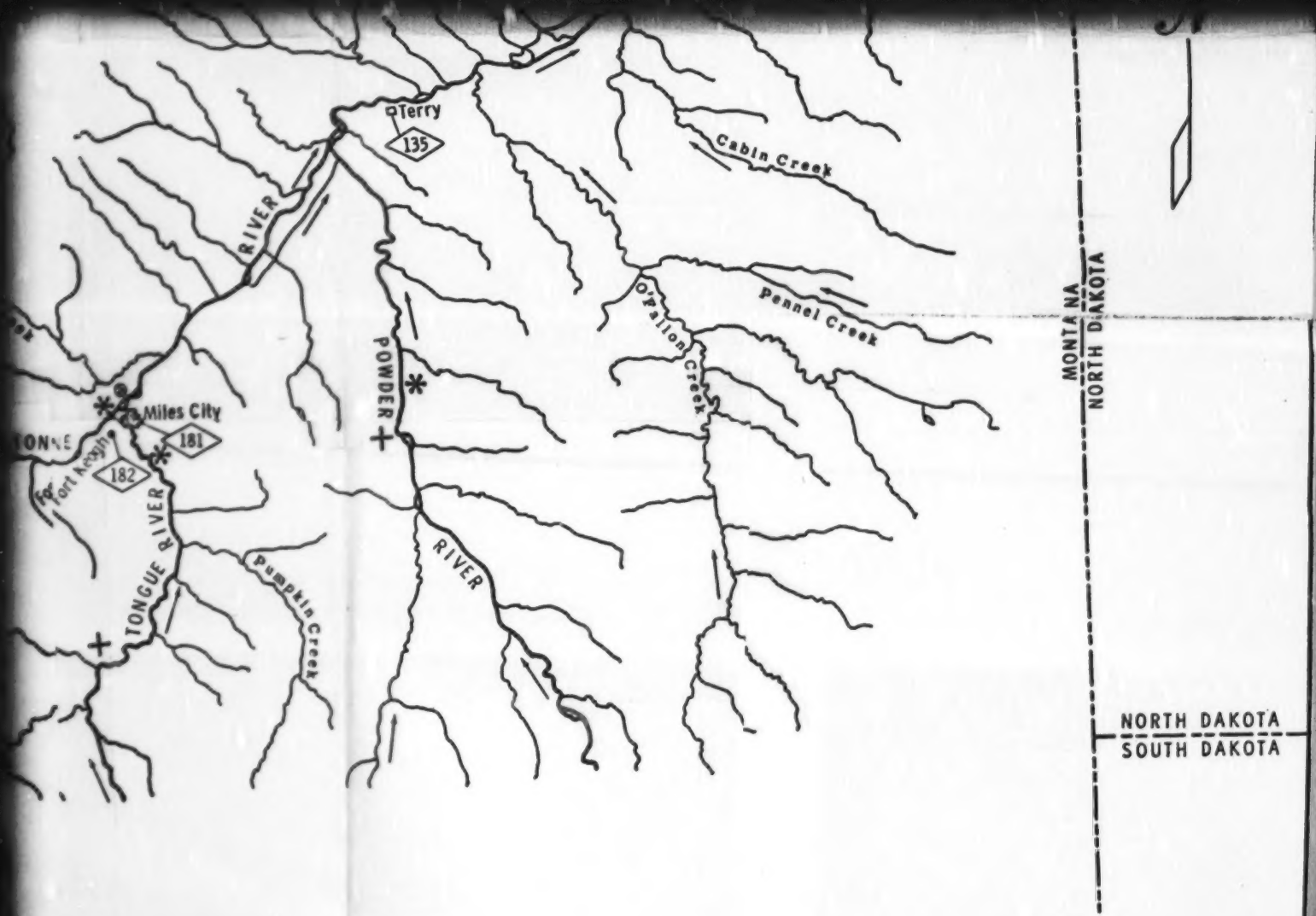
NE RIVER

ORTH DAKOTA

Williston
1,650
MISSOURI
RIVER
1,664
20
Fairview
RIVER
30
15
Sidney
YELLOWSTONE
MONTANA
NORTH DAKOTA
92.1
Glendive
Clear Creek
N
Cabin Creek
Pierry
135
RIVER
Pennel Creek
Otter Creek
MONTANA
NORTH DAKOTA
POWDER
Miles City
181
182
TONGUE RIVER
RIVER


Antelope Creek
YELLOWSTONE
Huntley
Billings
346
367
Laurel
YELLOWSTONE RIVER
Fork
Cooney Reservoir
Clark
Red Lodge
MONTANA
WYOMING
Clark
Fork
Sunlight Creek

Terry
135
Little Porcupine Creek
South Sunday Creek
North Sunday Creek
RIVER
Great Porcupine Creek
Porcupine Creek
POWDER
Miles City
181
YELLOWSTONE
182
Fort Keogh
Hysham
260
Forsyth
231
TONGUE RIVER
Pumpkin Creek
RIVER
Sarpy Creek
Rosebud Creek
Rosebud Creek
Miles above mouth of Mis
Miles above mouth of Yell
USGS Gaging Stations
USPHS National Water Q
Network Sampling Statio
Montana State Bacteriolo
Bighorn, Tongue, and P
are subjects of separate
Direction of flow
Miles
10
0
10



Miles above mouth of Missouri River

Miles above mouth of Yellowstone River

USGS Gaging Stations

USPHS National Water Quality Network Sampling Station

Montana State Bacteriological Stations

Bighorn, Tongue, and Powder Rivers are subjects of separate reports

Direction of flow

Miles

10 0 10 20 30